Chapter 6. Recovery

Chapter 5 defines recovery in the ARMP as rebuilding abalone populations to a self-sustainable level, and eventually to a condition where a fishery might be considered. Recovery, by this definition, applies to southern California populations, as well as red abalones in central California outside the range of the California sea otter. Recovering these abalones will take considerable effort over a long period of time. At least one abalone, the white abalone, is beyond its reproductive capacity to recover on its own, and is listed as an endangered species.

Of the seven California abalones, five were targeted in the abalone fishery. Two others, pinto and flat, were never a significant part of the fishery, and little is known about them. The recovery portion of this plan will focus primarily on red, pink, green, black, and white abalones. Nevertheless, flat and pinto abalones will be monitored and included in the activities mainly targeting the other species.

6.1 Goals

The recovery plan addresses three goals (two interim and one long-term):

1. To reverse the decline of abalone populations which are in jeopardy of extinction
2. To establish self-sustaining populations throughout their historic ranges
3. To reach sustainable fishery levels in at least three-quarters of the former range (Section 7.1.2.1).

Recovery activities are limited when populations are at very low levels. Any activity is likely to depend upon the successful completion of previous work, thus recovery activities are consecutive and stepwise (Figure 6-1). Abalones with decreased populations and reduced ranges must be first brought to a sustainable (stable) level, then allowed to rebuild to a population level where a fishery may be considered.

6.2 Criteria for Evaluation of Resource Recovery

Because recovery is a step-wise process, a set of criteria were developed to assess and evaluate the recovery process as it moves from one step to the next. Two kinds of criteria are used: size-based (Criterion 1) and density-based (Criterion 2 and Criterion 3).

6.2.1 Size Distribution-Based Assessment (Timed Surveys)

Abalone size distribution is used to evaluate whether Criterion 1 has been met. Size frequency can provide information about a local population's reproduction and growth. As much data as possible is collected from appropriate abalone habitat during the surveys. In addition to Department assessment surveys, size frequency data from a variety of sources can be utilized; for example, from Channel Islands National Park (CINP) Kelp Forest monitoring sites. While specific density data for abalone would be useful, conducting detailed, time-consuming, transect-based surveys of rare species is impractical given the available human resources for surveys.

Surveying for a defined length of time adds a rough means of comparing many similar surveys. Timed searches are more efficient at finding rare species because they

do not require transect setup and are adaptive, in that searches can be directed at likely habitat without being constrained by transect boundaries. Abalone that are found can be measured in place, providing size frequency data. The location of the dive can be fixed by a Global Positioning System (GPS) unit.

During deep water ROV and submarine searches, a tracking system is commonly employed, thus yielding an estimate of area searched, as well as a count of abalone. Intertidal black abalone searches can be tracked using a GPS unit during surveys. In these instances, density could be obtained as part of a Criterion 1 evaluation.

6.2.1.1 Criterion 1 - Broad Size Distribution Over the Former Abalone Range

Populations are more stable when there are higher numbers of individuals at multiple locations. To evaluate resource conditions using this measure, two categories, intermediate [100 mm to recreational minimum legal size (RMLS)], and large (larger than RMLS), are defined, and each of those categories is further sub-divided into 5 mm groups. When abalone observed during timed surveys (Appendix E) at an index site occupy 90 and 25 percent of the intermediate and large categories, respectively, then the size frequency aspect of Criterion 1 will have been met at that site (Table 6-1; Section 6.4.1.1). A category smaller than 100 mm is not used, because abalone smaller than 100 mm are usually cryptic and not easily assessed.

Fish and Game Code [§5522(a)(6)] also requires recovery at multiple locations. To meet this aspect of Criterion 1, the broad size distribution requirements must be fulfilled at multiple index sites (Tables 6-3 through 6-8).

The location of recovery areas were determined from commercial landing block data and known recreational fishing areas (Appendix D). Key locations, which are smaller areas within a larger recovery area (such as an island) are places where abalone have been known to occur. Index sites are selected from key locations, and are where population assessment and recovery activities will be carried out. Index site locations include a mixture of Department-selected locations, and locations where an already established site is monitored by another agency [such as the Channel Islands National Park (CINP) or Catalina Conservancy].

Because the marine environment is dynamic, habitat which once supported abalone may now be incapable of doing so. Alternative index sites may replace those currently selected to take into account changes in the marine environment. Furthermore, sea otter expansion, coastal development, sedimentation, pollution, and disease may act to reduce suitable abalone habitat. If this should occur in more than 50% of the recovery areas, then the long-term recovery goal for a fishery cannot be achieved (see section 6.2.2.2). The interim goal of re-establishing self-sustaining populations becomes the long-term goal.

When size category percentage values (90% and 25%) are met at one or more index sites, additional timed surveys will be conducted to evaluate the extent of this phase of recovery. If the criterion is only partly met (for instance, if only some of the index sites show evidence of reproduction and growth), timed surveys will continue.

When all the index sites for a species have met the size category percentage values, it is likely that the species could then be at a sustainable level (sufficient reproduction and growth) throughout its range and no longer at risk of extinction. This

Table 6-1. Recovery criteria and Fish and Game block number for recovery areas

Criteria	Species Red	Pink	Green	Black	White	Flat	Pinto
Interim							
Size frequency							
Criterion 1:							
Intermediate (between 99 and RMLS*) = 90%	X	X	X	>75mm<RMLS	X	>75mm<RMLS	>75mm<RMLS
Large (larger than RMLS) = 25%	X	X	X	X	X	X	X
Emergent Density							
Criterion 2: 2,000 per hectare	X	X	X	X	X	X	X
Long-term							
Emergent Density							
Criterion 3: 6,600 per hectare	X	X	X	X	X	X	X
Recovery areas by Fish and Game block # See also Appendix D	687 689 690 709 710 711 712 709 860 428 455 457 458 464 472	684 685 708 709 719 720 757 761 762 765 829 849 850 860 867 897	684 685 708 719 720 757 761 762 765 829 849 850 860 867	684 689 690 710 711 719 720 757 761 762 765 813 814 829 849 850 860 867	761 762 765 829 849 850 867 871 872 890 897	689 690 860 867	685 687 689 690 708 709 710 711 712 860

* RMLS = Recreational Minimum Legal Size: red=178 mm; pink, green, and white=152 mm; black=127 mm; pinto and flat=102 mm.

situation would fulfill the requirements for Criterion 1, and Criterion 2 would then be addressed, based on density surveys.

On the other hand, there is the possibility that the resource would continue to decline despite recovery efforts. This would be indicated by continual failure to identify locations with broad size distribution. In this situation, the recovery alternative, formal listing under the federal or state ESA may be initiated.

6.2.2 Density-Based Criteria

The density criteria (Criteria 2 and 3) presented here use average density levels which were derived from estimates determined from red abalone populations throughout California and published research. These density levels are used to identify when recovery has reached MVP and the upper boundary of the recovery range for all species of California abalones (Figure 5-1). As populations recover,

future research on individual species may allow refinement of the target densities that more closely reflect individual species population parameters.

6.2.2.1 Criterion 2 - First Density Level (2,000 ab/ha)

When Criterion 1 has been satisfied, emergent density surveys will be conducted in the key locations to determine average abalone density.

MVP is the density level that indicates that a stock is not at risk for collapse. The MVP used in the ARMP is based on two sources of information: minimum spawning densities determined by Shepherd and Brown (1993), and the density preceding sharp declines of red abalone in southern California (Tegner *et al.* 1989; Karpov *et al.* 1998) (Section 2.1.2.2). Shepherd and Brown (1993) found that recruitment started to decline when densities fell below 3,000 ab/ha. Stocks collapsed when adult densities fell below 1,000 ab/ha. Comparable densities and consequences were found with red abalone on Santa Rosa Island in southern California. Densities under 1,000 ab/ha were not sustainable and were followed by a collapse of the population (Karpov *et al.* 1998).

A MVP level was therefore established at 2,000 ab/ha for each species. Satisfaction of Criterion 2 does not trigger consideration of take. Criterion 2 requires that MVP levels must be achieved at all key locations in all recovery areas that continue to satisfy Criterion 1 (Section 6.4.1.2).

6.2.2.2 Criterion 3 - Fishery Density Level (6,600 ab/ha)

The attainment of Criterion 3 will directly address the long-term goal of fishery consideration. The targeted emergent abundance to fulfill Criterion 3 is 6,600 ab/ha. This number is based on data from surveys in 1999 and 2000 in the northern California red abalone fishery, and is the best available data on which to base an estimate of sustainable densities for an ongoing fishery (Section 7.1.2.1 - Criterion 2: Density).

Criterion 3 requires an average emergent density of 6,600 abalone/ha in at least three-quarters of the recovery areas. When the average density of abalone in all index sites within the recovery area reaches 6,600 ab/ha, the area may be considered recovered.

6.3 Fishery Consideration

Once Criterion 3 has been satisfied, an abalone species would no longer be included in recovery and a fishery may be considered. The species would then fall into the management part of the ARMP, Chapter 7. Specific details on the fishery consideration parameters are described in Section 7.1.4.1.

6.4 Recovery Activities

Recovery includes assessment and enhancement activities used to hasten the recovery process. Assessment will identify the status of current abalone populations in central and southern California, identify appropriate habitats where recovery activities can take place, and monitor the success of those activities.

6.4.1 Periodic Assessment of Abalone and Essential Habitat

Given the current condition of most abalone populations and the animal's slow growth, long life, and sporadic reproductive characteristics, a great amount of time will be required to reach a broad size range over a wide area. It would be of little use to conduct expensive surveys (such as band transects) annually for documentation purposes; thus, less frequent surveys will be conducted. Recovery assessment for abalone should be completed within a 5-year period for all species. Afterwards, the recovery plan should be re-evaluated using alternatives in Table 9-1.

To help maximize recovery assessments, data from other existing survey programs could be incorporated in to the assessments. Data from ongoing, long-term monitoring surveys and general ecological (broad scale) surveys such as the CINP Kelp Forest Monitoring Program and the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) program could be used, as well as information reported by constituents.

To maximize the efficiency of effort, two types of assessment surveys will be used. The first type of survey (timed surveys) is very general and quick, and is best for assessing small populations at the beginning of recovery (Criterion 1), while the second type (traditional emergent abalone transect surveys) is more detailed and takes longer, but is more appropriate for larger populations that are growing towards full recovery (Criterion 2 and Criterion 3).

6.4.1.1 Assessment for Criterion 1

Abalone habitat differences may impose different methods of assessment for some species when addressing Criterion 1:

Intertidal surveys for black abalone - This survey method consists of walking throughout intertidal habitat at extreme low tide periods, and searching rocky habitat including cracks, ledges, and tide pools.

Subtidal scuba surveys for pink, green, red, white, pinto, and flat abalones - This survey method consists of timed survey techniques as defined in Appendix E. Timed surveys are used for Criterion 1 evaluation when scuba diving is used.

ROV and submarine surveys for white abalone - The use of remote viewing equipment and submarine searches precludes the easy measurement of individual abalone, but laser reference points can assist in obtaining sizes for emergent abalone. ROV and submarine surveys are GPS-tracked, thus an estimate of the habitat area covered can be obtained. Even though ROV and submarine surveys provide density measures, they may not be as random as subtidal scuba surveys.

Criterion 1 assessments should be conducted every five years, and data to satisfy this criterion should be compiled and evaluated on a cumulative basis. The initial recovery assessment will be completed by 2005.

6.4.1.2 Assessment for Criterion 2

The recovery assessment at this level will consist of a density-based survey to obtain an emergent density estimate as well as size frequency information. Density and size frequency will be used to create a baseline database which will be important in any fishery management model that includes a quota.

As in the assessment for Criterion 1, recovery assessment will take place initially at index sites. When abalone populations at the index sites reach Criterion 2 levels, the recovery assessment will expand to encompass all of the key locations. Once all key locations attain Criterion 2 levels, then the second interim goal of establishing self-sustaining populations throughout historic abalone ranges will have been fulfilled.

6.4.1.3 Assessment for Criterion 3

Recovery assessment will involve the index sites, and when abalone populations there reach the Criterion 3 levels, then the long-term goal of reaching sustainable fishery levels in at least three-quarters of the former range is met.

6.4.2 Enhancement Activities

A variety of activities can assist in the recovery of depleted stocks. The first step towards the recovery of abalone populations in southern California was the closure of all abalone fishing south of San Francisco Bay. While the closure removes the fishing mortality on abalone, assuming no poaching, it does little toward active rebuilding of those populations. Continuation of this closure until a species has recovered is an underlying tenant of the ARMP. Further steps include a range of activities to prevent extinction, assist rebuilding, or increase the recovery rate. Enhancement activities may be the only way to fulfill the interim recovery goals. As populations recover and become self-sustaining, the need for these recovery techniques should be re-evaluated.

Recovery activities under the ARMP must not conflict with federal law. Both the ESA and the MMPA have provisions that may supercede or impact recovery efforts. ESA-listed species such as white abalone and sea otters are under federal, not state control.

6.4.2.1 Translocation or Aggregation of Adult Stocks

Translocation and aggregation of adult abalone are similar recovery techniques. Both involve the placement of abalone in closely aggregated groups in an attempt to bolster successful reproduction, with the end result of increasing local populations. The difference between the two techniques is in the magnitude of distance that abalone are transported to make the groupings. Translocation involves moving individuals away from areas at risk (due to poaching, pollution, etc.), or to distant areas in order to expand the range of the population by re-introduction. Aggregation is the re-arrangement of abalone within a given area so that they are closer to each other. This is useful when a population of an area is depleted and the remaining animals are spread too far apart for reproduction to occur.

There is good evidence that translocation of large abalone could be an effective way to bolster local populations. Tegner (1992) indicated that relocating adult broodstock is one of the few approaches to enhancement that has shown some promise. The study involved green abalone, but could be applicable to other species. In time, these small, aggregated groups could enlarge due to increased reproductive success.

Drawbacks to translocation and aggregation techniques include mortality during collection, transportation and replanting, absence and depletion of the source population, increased vulnerably to poaching, and disease transmission. Tegner (1992) had a 10 % mortality rate associated with transportation and replanting activities. Consideration of these drawbacks will be necessary when selecting sites for translocation and aggregation activities.

6.4.2.2 Larval Out-planting

Larval out-planting places millions of cultured larvae into optimal habitat. Although there is very high mortality of released larvae at the early stages of growth, saturating the habitat with larvae on consecutive occasions may have a positive effect on recovery. An additional benefit is the reduced cost of culture by releasing the abalone early in their development. This type of enhancement has been attempted and shows some promise. Further feasibility studies are necessary to determine if this technique is useful on a large scale. The Department is planning larval out-planting feasibility studies using red abalone at the northern Channel Islands. If the technique proves successful, it could be applied to other abalone species. Former commercial abalone fishermen are supportive of this technique and may volunteer time and resources to conduct out-planting.

6.4.2.3 Captive Breeding to Obtain Large Individuals for Out-planting

Tegner (1992) found that translocating large abalone was an effective means of increasing local numbers. A disadvantage to this method is the lack of sufficient available natural source populations. Aquaculture offers the ability to grow abalones to large size. Of the California abalones, red and green (Lapota *et al.* 2000) are currently being grown to sizes exceeding 100 mm. White abalone is currently in the early stages of being grown to large size as a potential source of individuals to increase local populations. Similar work for black abalone has been proposed, particularly for developing a WS-resistant strain.

While out-planting larger individuals offers advantages of decreased natural predation, and an increase in local reproductive potential, these animals are more likely to be poached (Henderson *et al.* 1988). Thus, it is important to have protected locations where out-planted abalones can be protected. Cultured abalone may behave differently from naturally-occurring abalone, and may not survive as well as native stock under natural conditions.

The cost of raising abalones to large size is high, but may be the most cost-effective method for rebuilding populations that are at risk of going extinct.

6.4.2.4 Establishing Marine Protected Areas

Edwards (1913) was the first to recognize that local declines in abalone could ultimately lead to loss of the resource as a whole. He was visionary in suggesting the establishment of protected reservations to function as breeding centers for abalone at 5 to 10 mile intervals along the coast. Marine Protected Areas (MPAs) for abalone could only be used in areas that still support minimum viable populations. MPAs, particularly marine reserves where no commercial or recreational take is allowed, are designed to conserve ecosystems and habitat, and reduce risks to the sustainability of

fishing. MPAs would benefit abalone recovery by providing a natural habitat where individuals could form the aggregations necessary for reproduction.

An MPA should be located in a remote area, away from population centers, in order to reduce take and the effects of pollution. Remote areas should be selected that would prolong the time of arrival of potential natural predators such as sea otters. It is likely that areas meeting this requirement would be found at the southern Channel Islands.

A second requirement is the presence of effective enforcement. Currently, there are few areas along the southern California mainland where abalone could be enhanced because protection of the abalone cannot be reasonably ensured.

Once abalone populations reach a self-sustainable level, recovery can move into the long-term phase. MPAs would continue to benefit abalone during the long-term phase by providing protection while the population grows towards fishery sustainability. After recovery, MPAs would continue to provide areas where abalone stocks could thrive in a natural marine environment. These areas would provide insurance against over-utilization of fished resources outside of the MPAs.

Specific areas for MPAs were not originally proposed in this plan because the proposal of MPA sites will take place under the MLPA. Proposals before the Fish and Game Commission for MPAs at the Channel Islands National Marine Sanctuary were approved in November 2002. Of the newly established Phase 1 sites (Figure 6-2), ten would provide areas suitable for abalone recovery.

6.4.3 Genetics and Disease Research

Active enhancement of abalone stocks will include aggregation, translocation and introduction of aquacultured abalone larvae, seed, or large individuals. Before any of these activities are attempted, certain genetic and disease concerns should be specifically addressed.

6.4.3.1 Genetics Research

In populations with extremely low abundance levels, there is a strong possibility that individuals may be genetically similar. Using these individuals in enhancement programs may result in restricted genetic characteristics (genetic bottlenecks) and cause reduced genetic diversity. A survey of individuals from many locations throughout the species' range should be conducted in order to estimate genetic diversity.

Knowledge of abalone genetics may be applied to genetic tag methods used to evaluate the success rates of out-planting. Genetic markers that may be unique to the southern California region could be a useful tool in enforcement of the moratorium.

Enhancement activities such as translocation and out-planting have potential genetic consequences from mixing genotypes of remote stocks and introducing cultured strains to natural populations. A part of active enhancement efforts should include attention to genetic concerns. Samples of individual abalone can be taken non-destructively and stored for future analysis.

Aggregation of abalones is the only activity which would not require genetic evaluation before proceeding, but genetic sampling would still be conducted as part of the overall abalone genetic investigation.

6.4.3.2 Disease Research

Disease, particularly WS, constitutes an important factor which might limit recovery operations in southern California for some species. Aggregating, out-planting and translocating individuals in California must allow for the possible effects of WS. Further research on the effects of WS on each species, and on possible resistance to WS, is needed. If resistance is not assured, such recovery operations should not be allowed.

6.5 Challenges to Abalone Recovery

There are a variety of challenges that may hinder abalone recovery. The extent of recovery for each species will depend on the severity of these challenges, which are identified and described below.

6.5.1 Disease

Disease can pose a threat to populations of invertebrates, which lack the immune system complexity of vertebrates. Resistance to disease develops at the level of the population rather than being acquired by individuals through previous exposure. The potential for development of genetically-based resistance at the population level is enhanced by large population size. If a fishery were opened or continued during an acute disease event, the healthy, and possibly most resistant, individuals would be removed by the fishery.

The extent to which WS has played a role in the apparent failure of population recovery since fishery closures is unknown. WS has a strong temperature component, in that elevated sea water temperature stimulates the development of the disease, which can be lethal (Friedman *et al.* 1997). Therefore, the impact of WS will be most apparent following severe El Niños and may increase if global climate change results in increased seawater temperatures. Recovery options must take into consideration the possible effects of this disease.

The Department monitors aquaculture facilities for introduced organisms and disease. There is currently a restriction on out-planting abalone from facilities which have not met certification standards. These regulations must be followed in all appropriate enhancement operations.

6.5.2 Sea Otters

Sea otters constitute a potential threat to the recovery of an abalone fishery in southern California. While sea otters and abalones co-existed along the California coast before 1850, the abalone likely occupied cryptic habitat inaccessible to otters, i.e., in crevices and under boulders. The establishment of an abundance of large invertebrates, i.e., abalone, crabs, sea urchins, and clams, found along the Pacific Coast is likely a result of severe declines in sea otters in the 19th Century, a result of fur trade hunting. The loss of the central California red abalone fishery in the 1960s demonstrated the effect that sea otters have on a fishery (Wendell 1994). Similar impacts on abalone fisheries occurred in British Columbia, Canada, (Watson and Smith 1996; Watson 2000).

While the central California fishery for red abalone was eliminated by sea otters, the red abalone resource still exists there in cryptic habitat which is not accessible to otters. These remaining populations are likely to be sustainable at lower population

numbers, and at a low biomass (Hines and Pearse 1982). While a few red abalone may be found in protected crevice habitat and under boulders within sea otter range, there would be insufficient individuals available to conduct a fishery. If a fishery were allowed, there is a possibility of extensive habitat damage from searching for large individuals, and such a fishery would provide additional opportunities for selling illegal take. A fishery based on smaller (cryptic) sizes would put the crevice-dwelling refuge population at risk.

In central California, a once-successful fishery was displaced by otter re-colonization, but in southern California there is concern that re-colonization by the sea otter would reduce an already depleted resource to even lower levels, possibly to extinction. Southern California populations need focused assessment to identify whether the crevice dwelling individuals are present in sufficient numbers to sustain the resource, if sea otters become a factor.

6.5.3 Other Challenges to Abalone Recovery

For a description of other challenges to abalone recovery, see Section 6.4.2.4, Establishing Marine Protected Areas; Chapter 8, Abalone Enforcement Activities, and Section 2.1.9, Mortality.

6.6 Recovery Approach

Within the overall strategy for abalone recovery, the unique needs of each abalone species must be considered. To facilitate an organized approach to recovery, the recovery needs are divided into specific tasks within four recovery categories and are sequentially numbered. Addressing these needs for each species will require the coordination of tasks. Where possible, the needs of multiple species will be addressed simultaneously. All of the recovery plans have similar task elements; however, there are differences in implementation (Table 6-2).

6.6.1 The General Recovery Plan

The recovery tasks are sequentially numbered for ease of identifying specific tasks. The numbering does not mean that tasks have to be done within sequential order. How the tasks are implemented for each species is outlined chapter 9 (Table 9-1).

6.6.1.1 Assessment of Habitat and Stock

Exploratory Surveys – Task 1

A primary need at the beginning of the recovery process is to assess the current status of all five species throughout their entire range. Exploratory surveys will be conducted at all key locations. Some of this work has already begun for some species (red, pink, black, and white abalones) but for no species is the assessment complete. Knowing the baseline status of the population is important to define the level of risk for survival of the species as well as to determine the level of recovery needed. This information will help prioritize recovery efforts so that species that are at risk of local extinction will receive more effort than those which are not. Exploratory surveys will provide information on current population levels and the location of aggregations. This

information will be used to identify areas in which to conduct recovery activities, and areas to protect.

The exploratory surveys for most species will be accomplished by using a timed survey (Tables 6-3 through 6-8). Surveys of deep, remote, offshore locations for white abalone will be conducted with a GPS-tracked submarine and/or ROV. The exploratory survey for black abalone will use an intertidal timed search survey conducted during low tide periods. Survey methodologies are explained in Appendix E.

These surveys will produce a GPS record of the general distribution of remaining abalone populations along with a general habitat description. The generalized stock assessment will also provide the current status of the population at the key locations. This information is important for determining the baseline from which recovery will be measured. Decisions on where and what type of recovery activities to employ can be made based on this information.

A collateral benefit of this task would be that data obtained from these exploratory surveys would include information on multiple abalone species distributions and habitat, since the depth ranges of these species overlap. Information on other invertebrates, fishes, and plants may be useful in the assessment and management of those species.

Detailed Surveys of Known Abalone Habitat – Task 2

The detailed surveys will expand upon the initial knowledge from the exploratory surveys by providing precise habitat descriptions, a baseline density estimate, and locations of abalone aggregations. Detailed surveys could be done immediately following the exploratory survey (Task 1) at a particular location on the same trip.

The detailed surveys will be similar to timed swim surveys except that a diver tracking device will be employed to map the divers' movements and record habitat and abalone location information (Appendix E).

This task will produce a detailed map of abalone habitat at selected areas. This habitat information will be put into a geographic information system (GIS) and used to generate habitat and community maps. Suitable areas for potential recovery activities could be identified at index sites or key locations. Identifying specific habitat types is essential for optimizing our recovery action efforts. The habitat information in the GIS would also be useful for other projects and species assessments.

Assessing Recovery – Task 3

Periodic assessment of any changes in the population is the core research task that will directly evaluate whether recovery criteria and goals have been satisfied. The survey technique used will vary depending on the level of recovery.

Assessment surveys for Criterion 1 will be the timed survey, intertidal walks, and submersible/ROV surveys (Appendix E). Following the achievement of Criterion 1, emergent density transects will be used to assess the achievement of Criterion 2 and Criterion 3. Other types of survey data will be incorporated from existing long-term sites monitored by other organizations and agencies.

Table 6-2. List of recovery activities with an estimate of field time required

Activity and task	Species	Time	Field time required
Assessment of Habitat and Stock			
Exploratory Surveys (Task 1)	R	I	5 dive days
	P	I	17 dive days (10 primary, 7 secondary*)
	G	I	24 dive days (14 primary, 10 secondary*)
	B	I	30 days low tide sampling
	W	I	40 days split between submersible & ROV
Detail Surveys (Task 2)	P	I	7 dive days
	G	I	15 dive days
	W	I	undetermined
Assessing Recovery (Task 3)	R	L	10 dive days over 5 yr period
	P	L	23 dive days over 5 yr period
	G	L	24 dive days over 5 yr period
	B	L	30 days low tide sampling over 5 yr period
	W	L	40 days submersible / ROV over 5 yr period
Research (enhancement activities)			
Culture (contract or support) (Task 4)	R	I	1 dive day to collect broodstock, 6- 12 mo to receive larvae
	G	L	continuous after feasibility study
	B	L	8 days broodstock collection, est. 7-10 yr culture
	W	I,L	continuous until de-listed
Out-planting Feasibility Studies (Task 5)	R(larval)	I	15 dive days (setup), 10 dive days/yr for 5 yr
	G	I	24 dive days/yr for 4 yr
	B	I	15 days/yr low tide sampling
	W	I, L	10 dive days/yr , 10 days/yr ROV for 5 yr
Aggregation Feasibility Study (Task 6)	P	I	7 dive days (setup), 5 dive days/yr for 4 yr
	G	I	7 dive days (setup), 5 dive days/yr for 4 yr
Translocation Feasibility Study (Task 6)	R	I	10 dive days (setup), 10 dive days/yr for 4 yr
	B	I	20 low tide sampling days/yr. for 4 yr
Aggregation (Task 7)	All	L	undetermined
Translocation (Task 7)	All	L	undetermined
Out-planting (adult, larval) (Task 8)	All	L	undetermined
Research (genetics and disease)			
Estimate Genetic Diversity (Task 9)	All	I	2 yrs. per species to complete lab analysis
Study of Resistance to WS (Task 10)	B	I	Estimated 2 yr
Involvement in Federal White Abalone Recovery Team (Task 11)	W	I, L	continuous until de-listed

Note: R= red, P= pink, G= green, B= black, W= white, I=interim, L=long-term
*see section 6.5.2.2 and 6.5.2.3

This task is crucial for determining the achievement of each recovery criterion. If this task is not done, there is no way to determine if a species is recovering or heading towards extinction.

Recovery assessments can encompass multiple abalone species all at once, because many of the abalone species occur in the same key recovery locations and have overlapping depth ranges.

6.6.1.2 Research (Enhancement Activities)

Develop or Support Existing Culture Programs – Task 4

Since the Department has no facilities for raising abalone, it must encourage abalone aquaculture companies to do the work. The Department can provide assistance by collecting broodstock and providing data on abalone disease issues through our Shellfish Health Laboratory.

The Department has already encouraged culture programs for white and green abalones for recovery out-planting. Culture programs for black and red abalones are planned and will be developed in the near future. The current culture programs and the planned black abalone program will raise abalone to adult sizes for out-planting into the natural environment. The planned red abalone culture program will produce larvae for out-planting. The production of adult and larval seed will initially be for small scale out-planting feasibility studies. If the feasibility studies show that the technique is worthwhile, the culture programs will expand operations to produce larger quantities of seed for out-planting. Inherent in the culture of abalone is the collection of wild broodstock. Broodstock could be collected during assessment activities, or from commercial facilities during the out-planting feasibility studies. If out-planting activities progress to a larger scale to enhance recovery (Task 8) , then formal controls to limit the collection of broodstock from the wild will have to be put into place. Controls on broodstock collection will insure that areas where broodstock is collected are not negatively impacted to the extent that recovery is significantly hampered.

In the course of culturing broodstock offspring, it may be necessary to cull a certain percentage of the population for various reasons. These culled individuals could be used for further research on pathology, larval or juvenile ecology, and other information that would help increase the success of out-planting.

Feasibility Study for Out-planting – Task 5

The out-planting of adult or larval abalone involves new techniques which must be evaluated before applying them on a larger scale. We must also develop protocols and determine locations for out-planting. Finding protected areas or deep areas that might provide *de facto* protection for the out-planted abalone is also important. Results should be evaluated at regular intervals, and if positive results cannot be verified after 5 years, this technique should be reconsidered.

The main product from this task is a scientifically-based determination of the effectiveness of larval and adult out-planting enhancement techniques. An additional product is the establishment of localized groups of abalone which may help to increase reproductive success. This task will also provide an out-plant protocol (for both adults and larvae) that could be applied to other abalone recovery efforts.

Feasibility Studies for Aggregation/Translocation – Task 6

In local areas, remaining abalone populations may be too dispersed for effective reproduction to occur. “Local areas” are defined as locations where surveys would normally be conducted. Aggregation of remnant abalone may be useful as a means of facilitating reproduction. Aggregation would not require genetic or disease evaluation of individuals, because individuals are from natural local populations. Aggregation would

only be appropriate for intertidal and subtidal scuba diving surveys. Aggregation feasibility studies will be conducted using pink and green abalones.

The steps for aggregation would involve the following:

- Survey area for abalone
- Mark location of abalone
- Evaluate numbers to determine if aggregation is warranted
- Locate appropriate habitat in which to aggregate
- Move abalone
- Tag abalone, if possible
- Determine GPS location
- Post-survey evaluation

A primary concern would be keeping abalone that are part of the local unit (in other words, part of a rocky point, cove, or kelp bed) in the area. The number and density of abalone which would trigger an aggregation study needs to be determined.

Translocation involves moving abalones longer distances, for example, re-locating abalone from inter-island locations. Translocation of abalone would be used to re-introduce stock to areas once populated by a high abundance of abalone. Translocation feasibility studies will be done using red and black abalones. Evaluation of donor and receiving locations should be made before an operation is conducted. Genetic and disease considerations would be evaluated.

The steps for translocation would involve the following:

- Determine and evaluate new location, including the presence of abalone, good habitat, food, and protection.
- Determine source location, including the presence of sufficient stocks
- Move abalone
- Tag abalone, if possible
- Determine GPS location
- Post-survey evaluation

The results of aggregation and translocation should be evaluated at regular intervals. If positive results from the use of these techniques cannot be verified after 5 years, these methods of enhancement should be reconsidered.

Aggregation and translocation are probably the only recovery activities that can be done for red, pink, green, and black abalones at the Channel Islands within the next 5-7 years. Before using these activities to boost recovery on a large scale, it is prudent to test them on a smaller scale. Information obtained might also be applicable to the recovery of other abalone species.

Aggregation or Translocation – Task 7

If the feasibility studies prove that aggregation and translocation are successful recovery activities, the next step is to evaluate following CEQA guidelines and if appropriate apply them to a larger recovery area. Based on the exploratory survey information, locations will be identified for either the aggregation or translocation

recovery activity. Specific methodology will be determined by the results of the feasibility studies. The immediate product will be an increase in the number of abalone in an aggregation, followed by successful reproduction and recruitment in areas where this task is applied.

If shown to be useful on a large scale, aggregation and translocation are probably the best and most cost-effective recovery activities to use for all abalone.

Out-planting – Task 8

If the feasibility study proves that larval and adult out-planting are successful recovery activities, the next step is to evaluate following CEQA guidelines and if appropriate apply them to a larger recovery area. Based on previous survey information, locations will be identified for out-planting. Methodologies determined during the feasibility study will be used to carry out this task on a larger scale in the selected locations. The immediate product will be an increase in the number of abalone in the areas where out-planting occurs.

6.6.1.3 Research (Genetics and Disease Studies)

Genetic Study: Estimation of Genetic Diversity - Task 9

A survey to collect genetic material from individuals at many locations within the species range should be conducted to estimate genetic diversity. Such surveys can be conducted without harm to the abalone. Very small tissue samples can be taken from abalone found on the exploratory surveys in Task 1. The equipment needed to conduct the genetic tests is available from academic institutions (such as the University of California). Population specialists under contract would evaluate the genetic data.

Evaluation of Resistance to WS - Task 10

The presence of a few old, large individuals at some locations indicates that some black abalone may be resistant to WS. Knowledge of the susceptibility of black abalone to WS would be useful in the development of a culture program, and in using any WS-resistant abalone for re-introduction to the natural habitat. It would also help determine if black abalone from the northern part of the range could be successfully translocated to southern areas.

We propose that an evaluation of this resistance be undertaken by the Department's Shellfish Health Laboratory before any movement of abalone is conducted. Black abalone will be collected from south-central California and the Channel Islands during low tide periods to test the hypothesis of resistance to WS.

Research on WS in black abalone could, and most likely would, be applied to other abalone species. With this information, aquaculture operations might be able to develop WS-resistant strains of abalone.

6.6.2 Recovery Plan Elements for Individual Species

6.6.2.1 Red Abalone

Task 1 - Exploratory Surveys

The majority of the population is currently concentrated at San Miguel Island, which is the western-most of the northern Channel Islands. Exploratory surveys will focus on Santa Rosa and Santa Cruz Islands, where red abalone historically occurred. Surveys will take place within the blocks and key locations listed in Table 6-3.

Task 2 - Detailed Surveys of Known Abalone Habitat

This task is not needed for red abalone because sufficient information is already available.

Task 3 - Assessing Recovery

Assessment surveys will be conducted at index sites and key locations in southern and central California (Table 6-3).

Task 4 - Develop or Support Existing Culture Programs

A certified (sabellid-free) aquaculture facility in southern California will be selected for culturing red abalone larvae for out-planting feasibility studies.

Task 5 - Out-planting Feasibility Study

Red abalone is the best candidate for a feasibility study on larval out-planting because red abalone larvae are readily available from established aquaculture facilities. The out-plant study will be located at Santa Rosa and Santa Cruz Islands.

Task 6 - Aggregation/Translocation Feasibility Studies

Translocation feasibility studies will be conducted at Santa Rosa Island and/or Santa Cruz Island. The source for translocation abalone will be San Miguel Island.

Task 7 - Aggregation or Translocation

These recovery techniques will be employed in the appropriate key locations.

Task 8 - Out-planting

Out-planting will occur in the appropriate key locations.

Task 9 - Genetics

A genetics study will be done to determine if sub-populations exist.

Table 6-3. Key locations for recovery of **red abalone** in southern and central California

Area	Block no.	Index	Key location
San Miguel Island	690 & 689	X	Crook Point to Cardwell Point
	689 & 690		Bay Point to Harris Point
	690		Harris Point to Otter Harbor
	690	X	Castle Rock (Otter Harbor to Point Bennett)
	690		Point Bennett to Judith Rock
	690	√	Judith Rock to Crook Point
Santa Rosa Island	689		Talcott Shoal and Sandy Point
	712		Sandy Point to Cluster Point
	711	X	Cluster Point to South Point
	711	√	South Point to Ford Point
Santa Cruz Island	687	X	West Point to Black Point
	687 & 709		Kinton Point to Posa Anchorage
	709	√	Morse Point to Laguna Harbor (Gull Island)
San Diego Area	860		La Jolla (Point La Jolla to Bird Rock)
	860		Point Loma (Mission Bay to Rathay Point)
	860	√	Point Loma (Rathay Point to Ballast Point)
Central California	457	X	SW Farallon Islands
	464	X	Fitzgerald Marine Reserve (San Mateo Co.)

X - Proposed DFG index recovery site
√ - External agency monitoring site

6.6.2.2 Pink Abalone

Task 1 - Exploratory Surveys

Areas selected for exploratory surveys are divided into primary and secondary tiers. The primary areas will encompass the DFG blocks where most landings occurred for both the recreational and commercial fisheries. The secondary areas will be surveyed at a later date when time, weather, and personnel availability allow. Primary surveys will be conducted at Santa Cruz Island, Anacapa Island, Santa Barbara Island, and Santa Catalina Island; and the mainland at San Diego. Secondary survey areas include San Clemente Island, Cortes Bank, Palos Verdes Peninsula, and Dana Point. The specific areas where surveys will occur are listed as key locations for recovery in Table 6-4.

Task 2 - Detailed Surveys of Known Abalone Habitat

Areas for detailed surveys will be selected based on findings of exploratory surveys at the primary islands. Areas at San Clemente Island will be selected based on past surveys.

Task 3 - Assessing Recovery

Assessment surveys will be conducted at the index sites and key locations (Table 6-4).

Task 4 - Develop or Support Existing Culture Programs

There is no existing or planned culture program for pink abalone.

Task 5 - Out-planting Feasibility Study

Because there is no culture program, out-planting cannot be done.

Task 6 - Aggregation/Translocation Feasibility Studies

An aggregation feasibility study will be conducted on the west and south sides of San Clemente Island.

Task 7 - Aggregation or Translocation

These recovery techniques will be employed at the key locations found appropriate according to the results of Task 1 and 2.

Task 8 - Out-planting

This recovery technique will be employed if a culture program is developed which will supply larvae and/or seed abalone.

Task 9 - Genetics

A genetics study will be done to determine if sub-populations exist.

Table 6-4. Key locations for recovery of **pink abalone** in southern California

Area	Block no.	Index	Key location
Anacapa Island	684		Bat Ray Cove to West End
	684		West End to East Fish Camp
	684	√	East Anacapa
Santa Cruz Island	685	√	Cavern Point to San Pedro Point
	685		San Pedro Point to Sandstone Point
	708	√	Sandstone Point to Valley Anchorage
	709		Albert Anchorage to Laguna Harbor
	709 & 710	√	Gull Island (Laguna Harbor to Morse Point)
Santa Barbara Island	765		South Side (Sutil Island to Grave Canyon)
	765	X	West Side (Webster Point to Sutil Island)
	765		North Side (Arch Point to Webster Point)
Santa Catalina Island	761		Isthmus Cove Area (Ship Rock, Bird Rock etc.)
	761	√	Long Point to Empire Landing
	761	√	Little Harbor to Ben Weston Point
	761		Ben Weston Point to Painted Cliffs
	762	X	Eagle Reef to Stony Point
	762		Stony Point to West End
	762		West End to Ribbon Rock
	762	X	Ribbon Rock to Catalina Head
	762		Farnsworth Bank
San Clemente Island	829		Northwest Harbor to Castle Rock
	849		Little Flower to White Rock
	849 & 850	X	West Cove south 3 Nautical miles
	850		Eel Point north 3 Nautical miles
	850	X	Eel Point to Mail Point
	850		Mail Point to Lost Point
	849 & 867		Lost Point to Cove Point
	867	X	China Point to Pyramid Head
Cortez Bank	897		Bishop Rock
Palos Verdes Penninsula	720		Haggerty's to Lunada Bay
	720		Lunada Bay to Abalone Cove
	719		Abalone Cove to Point Fermin
Dana Point	757		Pelican Point to Laguna Main Beach
	757		Laguna Main Beach to Dana Point
San Diego Area	860		La Jolla (Point La Jolla to Bird Rock)
	860		Point Loma (Mission Bay to Rathay Point)
	860	√	Point Loma (Rathay Point to Ballast Point)

X - Proposed DFG index recovery site
√ - External agency monitoring site

6.6.2.3 Green Abalone

Task 1 - Exploratory Surveys

Few areas have been thoroughly evaluated for remaining green abalone populations, but evidence suggests that populations are at very low levels. The primary survey areas will be centered around the southern Channel Islands: San Clemente Island, Santa Catalina Island, and Santa Barbara Island. Secondary survey areas include Santa Cruz Island, Anacapa Island, Palos Verdes Peninsula, Dana Point, and the San Diego area (Table 6-5).

Task 2 - Detailed Surveys of Known Abalone Habitat

Areas for detailed surveys will be selected based on findings of exploratory surveys at the primary survey islands. Areas at San Clemente Island will be selected based on past surveys.

Task 3 - Assessing Recovery

Assessment surveys will be conducted at the index sites and key locations (Table 6-5).

Task 4 - Develop or Support Existing Culture Programs

The culture of green abalone is being conducted by the U. S. Navy and the City of San Diego. The project received grant funding from the California Resources Agency in 2002.

Task 5 - Out-planting Feasibility Study

The Navy project is focused on out-planting large (3-4 in.) green abalone in the vicinity of Point Loma.

Task 6 - Aggregation/Translocation Feasibility Studies

An aggregation feasibility study will be conducted at San Clemente Island.

Task 7 - Aggregation or Translocation

These recovery techniques will be employed at the appropriate key locations.

Task 8 - Out-planting

This recovery technique will be employed at the appropriate key locations.

Task 9 - Genetics

A genetics study will be done to determine if sub-populations exist.

Table 6-5. Key locations for recovery of **green abalone** in southern California

Area	Block no.	Index	Key location
Anacapa Island	684		Bat Ray Cove to West End
	684		West End to East Fish Camp
	684	√	East Anacapa
Santa Cruz Island	685	√	Cavern Point to San Pedro Point
	685		San Pedro Point to Sandstone Point
	708		Sandstone Point to Valley Anchorage
Santa Barbara Island	765		South Side (Sutil Island to Grave Canyon)
	765		West Side (Webster Point to Sutil Island)
	765	X	North Side (Arch Point to Webster Point)
Santa Catalina Island	761	X	Isthmus Cove Area (Ship Rock, Bird Rock)
	761	√	Long Point to Empire Landing
	761	√	Little Harbor to Ben Weston Point
	761		Ben Weston Point to Painted Cliffs
	762	√	Eagle Reef to Stony Point
	762	X	Stony Point to West End
	762		West End to Ribbon Rock
	762	X	Ribbon Rock to Catalina Head
	762		Farnsworth Bank
San Clemente Island	829		Northwest Harbor to Castle Rock
	849		Little Flower to White Rock
	849 & 850	X	West Cove south 3 Nautical miles
	850		Eel Point north 3 Nautical miles
	850	X	Eel Point to Mail Point
	850		Mail Point to Lost Point
	849 & 867		Lost Point to Cove Point
	867	X	China Point to Pyramid Head
Palos Verdes Penninsula	720		Haggerty's to Lunada Bay
	720		Lunada Bay to Abalone Cove
	719		Abalone Cove to Point Fermin
Dana Point	757		Pelican Point to Laguna Main Beach
	757		Laguna Main Beach to Dana Point
San Diego Area	860		La Jolla (Point La Jolla to Bird Rock)
	860		Point Loma (Mission Bay to Rathay Point)
	860	√	Point Loma (Rathay Point to Ballast Point)

X - Proposed DFG index recovery site
√ - External agency monitoring site

6.6.2.4 Black Abalone

Task 1 - Exploratory Surveys

Black abalone distribution is relatively well known throughout southern California, including the Channel Islands. This species also occurs in central California, where information about its distribution and abundance is poor. Surveys in the Monterey/Carmel area and reports of poaching in the northern part of central California suggest that a fairly good population remains. Exploratory surveys will be conducted in central California (from San Luis Obispo to Mendocino County) to determine relative abundances of black abalone and if these populations could serve as sources for translocation of animals to depleted areas in southern California.

Task 2 - Detailed Surveys of Known Abalone Habitat

This task is not needed for black abalone because sufficient information is already available.

Task 3 - Assessing Recovery

Surveys will be conducted at the index sites and key locations (Table 6-6).

Task 4 - Develop or Support Existing Culture Programs

Currently, black abalone has not been successfully cultured. Culture programs for black abalone are important to develop a source of stock for out-planting, and in order to answer questions about withering syndrome.

Task 5 - Out-planting Feasibility Study

The locations for out-planting depends on having areas that are well protected from poaching. Black abalone are accessible and easily seen by people during low tide periods and thus are very susceptible to poaching. Few (if any) areas on the southern California mainland would be acceptable for enhancement. Areas at the Channel Islands or mainland areas along the central California coast would provide suitable habitat that could be adequately protected.

Task 6 - Aggregation/Translocation Feasibility Studies

Abalone from the northern portion of the central California coast will be translocated to the southern portion of the central California coast.

Task 7 - Aggregation or Translocation

These recovery techniques will be employed at the appropriate key locations.

Task 8 - Out-Planting

Black abalone will be out-planted at the appropriate key locations.

Task 9 - Genetics

A genetics study will be done to determine if sub-populations exist.

Task 10 - Resistence to WS

Central California black abalone populations will be evaluated for WS resistence.

Table 6-6. Key locations for recovery of **black abalone** in southern California

Area	Block no.	Index	Key location
San Miguel Island	690 & 689		Crook Point to Cardwell Point
	689 & 690	√	Bay Point to Harris Point
	690	√	Harris Point to Otter Harbor
	690		Otter Harbor to Point Bennett
	690	√	Judith Rock to Crook Point
Santa Rosa Island	689	√	Tecolote Point to Sandy Point
	711	√	Sandy Point to Cluster Point
	711	√	Johnson's Lee to Ford Point
	711 & 710		Ford Point to East Point
Anacapa Island	684	√	Bat Ray Cove to West End
	684		West End to East Fish Camp
Santa Barbara Island	765		Arch Point to Webster Point
	765		Webster Point to Sutil Island
	765		Sutil Island to Sea Lion Rookery
San Nicolas Island	813		All Rocky Intertidal Areas
	814	X	All Rocky Intertidal Areas
Santa Catalina Island	761	X	Long Point to Empire Landing
	761		Little Harbor to Ben Weston Point
	762	X	Eagle Reef to Stony Point
	762		Stony Point to West End
	762		West End to Ribbon Rock
	762		Ribbon Rock to Catalina Head
San Clemente Island	829	X	Northwest Harbor to West Cove
	849		Little Flower to White Rock
	849 & 850		West Cove south 3 Nautical miles
	850	X	Eel Point north 3 Nautical miles
	850		Eel Point to Mail Point
	850		Mail Point to Lost Point
	849 & 867		Lost Point to Cove Point
	867		China Point to Pyramid Head
Palos Verdes Penninsula	720		Haggerty's to Lunada Bay
	720		Lunada Bay to Abalone Cove
	719		Abalone Cove to Point Fermin
Dana Point	757		Pelican Point to Laguna Main Beach
	757		Laguna Main Beach to Dana Point
San Diego Area	860		La Jolla (Point La Jolla to Bird Rock)
	860		Point Loma (Mission Bay to Rathay Point)
	860	√	Point Loma (Rathay Point to Ballast Point)

X - Proposed DFG index recovery site
√ - External agency monitoring site

6.6.2.5 White Abalone

White abalone is listed under the federal ESA. Recovery tasks at this time do not involve actual handling of abalone since a special permit is required from NMFS.

Task 1 - Exploratory Surveys

White abalone is at an extremely low population level, and most of the recently observed individuals have been large and solitary, which indicates that the population has experienced reproductive failure and is senescent. No recruitment of small individuals was observed during scuba or submarine surveys, but two individuals were observed at Santa Cruz Island (Davis *et al.* 1998). Further exploratory surveys are needed to delineate critical abalone habitat for this federally-listed endangered species.

Submarine and ROV surveys will take place at Tanner and Cortez Banks because there are more white abalone there than elsewhere. San Clemente and Santa Barbara Islands will be surveyed because they are near the center of white abalone distribution.

Task 2 - Detailed Surveys of Known Abalone Habitat

Data will have already been collected through the video recordings by submersible or ROV surveys in the exploratory survey (Task 1).

Task 3 - Assessing Recovery

Assessment surveys will be conducted at the index sites and key locations (Table 6-7).

Task 4 - Develop or Support Existing Culture Programs

Prior to its listing under the ESA, the Department participated in the collection of white abalone for culture, in conjunction with University of California, Santa Barbara, and the Channel Islands Marine Research Institute (CIMRI). A spawn in 2001 produced several hundred thousand progeny which are currently being held at CIMRI until they are at least 100 mm long (4 in.), at which time they would be experimentally out-planted (subject to federal approval). Some of these individuals could also be used to expand the culture program at other facilities. Growing cultured abalone to a large size for out-planting has never been attempted before, and this work should be considered experimental.

While not specifically part of this task, the establishment of alternative culture facilities for growing white abalone would be encouraged. Expanding the culture program would reduce the risk of catastrophic system failure and loss of the recovery program.

Tasks 5-9

These tasks will not be implemented under the ARMP due to the white abalone's status as an endangered species.

Task 10 - Evaluation of Resistance to Withering Syndrome

The Department's Shellfish Laboratory may investigate the effects of withering syndrome in white abalone.

Task 11 - Involvement in the Federal White Abalone Recovery Team

Working with this species would involve interaction with or participating on the White Abalone Recovery Team, established by the NMFS. Interaction with the NMFS on white abalone recovery will establish a direct working relationship with federal agency personnel, which may be useful if other abalone species are listed under the ESA.

Table 6-7. Key locations for recovery of **white abalone** in southern California

Area	Block no.	Index	Key location
Santa Barbara Island	765		Arch Point to Webster Point (Foul Area)
	765	X	Webster Point to Sutil Island
	765		Sutil Island to Grave Canyon
Santa Catalina Island	761	X	Isthmus Cove Area (Ship Rock, Bird Rock)
	761		Long Point to Blue Cavern Point
	762		Eagle Reef to Stony Point
	762		Farnsworth Bank
San Clemente Island	829	X	Northwest Harbor to Castle Rock
	849		Little Flower to White Rock
	849 & 850	X	West Cove south 3 Nautical miles
	850		Eel Point north 3 Nautical miles
	850	X	Eel Point to Mail Point
	850		Mail Point to Lost Point
	849 & 867		Lost Point to Cove Point
	867	X	China Point to Pyramid Head
Tanner Bank	872		All Suitable Habitat
	871		All Suitable Habitat
Cortez Bank	890		All Suitable Habitat
	897	X	All Suitable Habitat

X - Proposed DFG index recovery site
√ - External agency monitoring site

6.6.2.6 Pinto Abalone and Flat Abalone

Task 1 - Exploratory Surveys

Exploratory surveys will be done in conjunction with other exploratory surveys of the five major species.

Task 2 - Detailed Surveys of Known Abalone Habitat

Detailed survey data collected for other species will be used for pinto and flat abalones in areas where they may co-occur.

Task 3 - Assessing Recovery

Assessment surveys will be conducted at the index locations (Table 6-8).

Tasks 4-9

These tasks will not be implemented for these species.

Task 10 - Evaluation of Resistance to WS

The Department's Shellfish Laboratory may investigate the effects of withering syndrome in pinto and flat abalone.

Table 6-8. Key locations for recovery of **pinto and flat abalones** in southern California

Area	Block no.	Index	Key location
San Miguel Island	690 & 689	X	Crook Point to Cardwell Point
pinto and flat abalones	689 & 690		Bay Point to Harris Point
	690		Harris Point to Otter Harbor
	690	X	Castle Rock (Otter Harbor to Point Bennett)
	690		Point Bennett to Judith Rock
	690	√	Judith Rock to Crook Point
Santa Rosa Island	689		Talcott Shoal and Sandy Point
pinto abalone	712		Sandy Point to Cluster Point
	711	X	Cluster Point to South Point
	711	√	South Point to Ford Point
Santa Cruz Island	685	√	Cavern Point to San Pedro Point
pinto abalone	685		San Pedro Point to Sandstone Point
	687	X	West Point to Black Point
	687 & 709		Kinton Point to Posa Anchorage
	708	√	Sandstone Point to Valley Anchorage
	709	√	Morse Point to Laguna Harbor (Gull Island)
	709		Albert Anchorage to Laguna Harbor
	709 & 710	√	Gull Island (Laguna Harbor to Morse Point)
San Diego Area	860		La Jolla (Point La Jolla to Bird Rock)
pinto and flat abalones	860		Point Loma (Mission Bay to Rathay Point)
	860	√	Point Loma (Rathay Point to Ballast Point)
San Clemente Island	867	X	China Point to Pyramid Head
flat abalone			

X - Proposed DFG index recovery site
√ - External agency monitoring site

6.7 Timelines

There are two timelines in the ARMP, one for the recovery of the abalone resource (presented in this chapter) and one for the implementation of elements of the recovery plan (presented in section 9.2).

Abalone recovery will probably take many decades. There is doubt whether some species are capable of recovery without human intervention. Many areas where abalone once lived have been without any abalone populations for many years, as a result of local pollution, climatic change, overfishing, and disease. Some of these events continue to occur, thus making recovery more difficult.

The minimum time for the achievement of Criterion 1 is related to the growth rates of the abalone: faster-growing species will satisfy Criterion 1 more quickly. Red

and possibly pink abalones will most likely reach this first level of recovery more quickly than the green, black, and white abalones. The latter two species may take much longer to reach this level because they are starting from a very low population level.

Estimates of time for each species to reach Criterion 1 are given in Table 6-9. The estimates are based on optimum conditions and enhancement activities which would produce the best scenario possible, given the growth rate of each species. The estimates are projections starting from time when recovery activities begin, and do not account for the initial time needed to determine if the recovery activities are worthwhile. Factors such as poaching, El Niños, or other major environmental perturbations will increase the time needed to achieve Criterion 1 levels.

For red abalone, the time required to achieve a broad size range may take 6 to 11 years, because the small and medium-size abalone will have to come entirely from successful settlement and recruitment every year. This is the absolute minimum time needed to allow newly recruited abalone to grow and fill in the intermediate cohorts of the size distribution. It will take even longer to see increased numbers and size ranges throughout the historic range.

To achieve Criterion 2 and Criterion 3 may take decades, and estimating the time needed to reach them would be purely speculative at this time. Once species reach Criterion 1 levels, an estimate of the time necessary to reach the next level of recovery may be possible. Future time estimates for recovery can be added or revised in the ARMP as recovery progresses and more information becomes available.

Table 6-9. Estimates for the amount of time for recovery of five species of abalone in southern California. Time estimates for criterion 1 are based on the estimate of ages at recreational minimum legal sizes.

Species	Criterion 1	Criterion 2	Criterion 3
Red	6-11 yrs [1]	?	?
Pink	14-16 yrs [2]	?	?
Green	14-20 yrs [2]	?	?
Black	20+ yrs [3]	?	?
White	9+ yrs [2]	?	?

1 Haaker *et al.* 1998
2 Tutschulte 1976
3 Haaker *et al.* 1995

6.8 Alternative Approaches to Recovery

During the early stages of resource recovery (before Criterion 1 is met) few alternatives are available (Section 6.2.1.1). If early recovery cannot be demonstrated, the only alternative approach is to propose listing under Federal or State Endangered Species Act (ESA).

On the other hand, if recovery is successfully progressing, there could be a desire to consider reopening a fishery even though recovery has not reached its goals. Alternate approaches that allow fishing to occur prior to complete recovery (Criterion 3 - Section 6.2.2.2) are considered under Management Alternatives (Section 7.3)

6.8.1 Alternative 1 - Listing of Species that Fail to Recover

If recovery cannot be demonstrated by broadening size ranges or evidence of recruitment throughout a species' former range (Section 6.2.1.1), then listing on the

California or Federal ESA is warranted. Listing would convey extraordinary protection, and perhaps provide further resources to prevent extinction of the species.

Pros:

- Conveys special protected status to the species at risk
- Provides additional resources and funding for further recovery work
- Increases public awareness of marina species problems

Cons:

- Increases possibility of sea-floor conflicts; listing under Federal ESA may prevent access to resources and areas still occupied by the listed species